High Temperature Electronics

Completed Technology Project (2015 - 2018)

Project Introduction

The exploration of Venus is of fundamental importance in understanding the history and evolution of earth, especially related to climate change. A fundamental measurement with revolutionary scientific implications in understanding Venus' conditions and evolution is seismometry. There are notable scientific questions that can be answered by Venus seismometry. For example, the 2011 Planetary Science Decadal Survey listed a Venus seismic network as part of a small list of important mission types that could be enabled given that technology support for developing high temperature sensors and electronic systems can be provided. A Key Capability for this network is "Long duration high-temperature subsystems". NASA's Venus Exploration Analysis Group (VEXAG) has also recognized the importance of seismology in future Venus exploration. However, seismometry on Venus is highly challenging due to the extreme planetary operational conditions, and the need for in-situ operation of a seismometer for strong coupling to the planetary surface. Under a previous Planetary Instrument Definition and Development (PIDDP) project, we successfully demonstrated the technologies associated with a proof-of-concept high temperature seismometer design. This included the basic transition of a standard and well-accepted seismometer design to a high temperature analog, operation of the seismometer structure at Venus temperatures, and a circuit at Venus temperatures that responded to changes in motion of the seismometer position sensor and wirelessly transmitted that data over extended times (24 days). Based on this approach, under this proposal we will design, fabricate, and test a first generation high temperature seismometer based on targeted scientific objectives. Four science objectives related to the structure of the crust, mantle, and core of Venus are defined, which then determine the seismometer requirements. A pathway for achieving these requirements is presented based on the PIDDP development and recent advancements in high temperature technologies. A core feature of this proposal is the use of significantly more capable high temperature circuits early in the project to provide a substantially improved seismometer. Further integrated circuit refinements are expected during the course of this project to then produce a viable prototype seismometer. Integrating these improvements in high temperature electronics into our seismic sensor design will expand the operating frequency range and the amplitude sensitivity of the sensor and enable operations at the Venus ambient temperature of 470°C for extended periods of time. This proposal combines the team of scientists and developers that produced the proof-of-concept system with a scientist specializing in the design and implementation of seismometer systems on the nearest earth equivalent: the bottom of the ocean. The approach is that the Venus scientific direction will be set by a planetary scientist (Lunar and Planetary Institute), the seismometer design by an expert in marine seismometer design (Columbia University), implemented by high temperature sensors and electronics developers (NASA Glenn Research Center and Inprox Technology Corporation), and basic operation demonstrated in the laboratory and a simulated Venus environment at the NASA Glenn Extreme Environment

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Planetary Instrument Concepts for the Advancement of Solar System Observations

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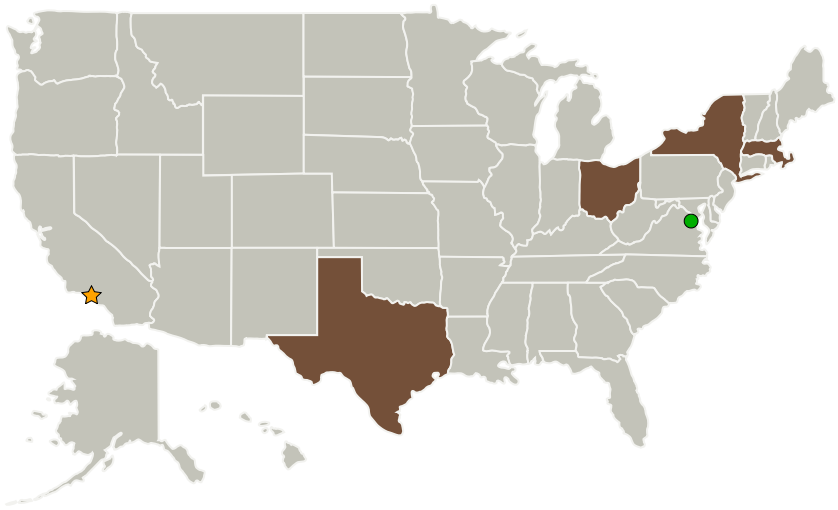
Rig. A major objective of this work is to prepare the system for a MatISSE proposal and improve readiness for possible missions, e.g., New Frontiers. Thus, world-leaders in their respective fields combine efforts to produce a technology of high interest to Venus exploration. The proposed spacecraft instrument development work is relevant to the PICASSO program because the entry TRL is 2-3 and the exit TRL is 4.

Anticipated Benefits

Significantly expands the range of possible Science Venus missions, but it also has direct relevance to other planetary missions with high pressure, radiation, and potentially high temperature, such as missions to gas giants. Results of this work are the foundation of present development of a proof-of-concept long-lived lander probe.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
●NASA Headquarters(HQ)	Supporting Organization	NASA Center	Washington, District of Columbia

Project Management

Program Director:
Carolyn R Mercer

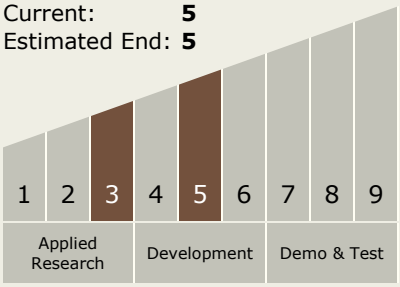
Program Manager:
Haris Riris

Principal Investigator:
Gary W Hunter

Co-Investigators:
George E Ponchak
Ann P Over
Philip G Neudeck
Walter S Kiefer
Gordon B Taylor
Spahr C Webb

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors

Continued on following page.

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Primary U.S. Work Locations	
Massachusetts	New York
Ohio	Texas

Technology Areas *(cont.)*

- TX08.3.4 Environment Sensors

Target Destination

Others Inside the Solar System